Article

Survey of western Canadian beef producers regarding calf-hood diseases, management practices, and veterinary service usage

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Abstract — Cow-calf producers in western Canada were surveyed in June 2010 regarding calf-hood diseases and veterinary service usage; 310 producers responded. Use of veterinary services, particularly herd-health related services, increased with herd size as did neonatal diarrhea and clostridial vaccine usage. Administration of clostridial vaccines to pregnant dams before calving was associated with a reduction in neonatal diarrhea treatments; however, there was no association between neonatal diarrhea vaccine usage and a reduction in diarrhea treatments. Producers with > 220 breeding females were more likely than those with < 85 breeding females to seek veterinary advice regarding treating sick calves, have a veterinarian necropsy dead calves, have a veterinarian pregnancy check their bred females, and evaluate their herd bulls for breeding soundness.

Résumé — Sondage auprès des producteurs de bovins de boucherie canadiens concernant les maladies des veaux, les pratiques de gestion et l'usage des services vétérinaires. Un sondage a été réalisé en juin 2010 auprès d'éleveurs-naisseurs de l'Ouest canadien sur les maladies des veaux et l'usage des services vétérinaires; 310 producteurs ont répondu. L'usage des services vétérinaires, particulièrement les services associés à la santé du troupeau, augmentait en fonction de la taille du troupeau, tout comme la diarrhée néonatale et l'usage du vaccin clostridial. L'administration de vaccins clostridiaux aux vaches gravides avant le vêlage a été associée à une réduction des traitements de la diarrhée néonatale; cependant, il n'y avait aucune association entre l'usage de vaccins néonataux et une réduction des traitements de la diarrhée. Il était plus probable que les producteurs ayant > 220 femelles reproductrices obtiennent des conseils vétérinaires concernant le traitement des veaux malades, demandent à un vétérinaire de réaliser une nécropsie des veaux morts, aient une consultation gestationnelle avec un vétérinaire pour les femelles accouplées et évaluent les taureaux du troupeau pour l'aptitude à l'utilisation comme reproducteur que les producteurs ayant < 85 femelles d'élevage.

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Introduction

Reports from veterinary practitioners in western Canada, along with information from outbreak investigations performed by the Western College of Veterinary Medicine's Disease Investigation Unit (DIU), suggest that the nature of neonatal and calf-hood diseases may be changing. For example, the DIU has investigated several herds with high diarrhea-associated mortality (i.e., 80%), affecting 3- to 6-week-old calves, for which there was no etiologic diagnosis despite intensive diagnostic workup. These novel cases of diarrhea might represent the evolution of known pathogens or the emergence of new infectious agents. Regardless, the question that arises is, why now?

The classic epidemiological approach to understanding infectious diseases is to place the disease within the context of the epidemiological triangle. That is, to view disease as a complex interaction among the infectious agent, the host (animal), and the environment. With respect to the environment, consolidation within the livestock industry is leading to fewer but much larger operations. The number of farming operations in Canada has been in decline since 1941 (1) and this trend is continuing (2). Consolidation is being driven by demographics (1) and economics (3). As a result, the larger operations tend to employ different management practices and focus more on the health of the herd than the individual animal. For example, low-cost overwintering systems like bale and swath grazing allow large numbers of cattle to remain on expansive tracts of land, thereby altering infection pressures (4). While herd size and changing management practices may be altering the epidemiology of diseases affecting nursing beef calves, there are limited Canadian data available to critically evaluate this premise.

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The United States Department of Agriculture (USDA) initiated the National Animal Health Monitoring System (NAHMS) in 1983 to collect, analyze, and disseminate data relating to animal health, management practices, and productivity (5). Over the last 20 years the NAHMS has provided detailed data on management practices, nutrition, vaccine usage, and disease-specific morbidity and mortality rates (6). The Canadian industry does not have a comparable system for monitoring its livestock sectors.

Current data are needed to better understand the evolution of western Canadian cow-calf operations. This study was designed to examine the occurrence and age distribution of neonatal diarrhea (calf scours) and other important calf-hood diseases in western Canadian beef herds that are serviced by veterinarians. A second objective was to describe use of vaccines, colostrum supplements, antimicrobials, ancillary treatments, and veterinary services in these herds. The final objective was to determine if management practices were associated with neonatal and calf-hood morbidity and mortality rates.

Materials and methods

Recruitment of veterinary practices

A database of all veterinary practices in western Canada was compiled from the provincial veterinary directories of Manitoba, Saskatchewan, Alberta, and British Columbia. A subset of practices likely to have a substantial proportion of beef cattle clients was identified using a combination of practice name, practice listed in the provincial directory as either mixed or food animal, geographical location, and the authors' first-hand knowledge of the practice.

From the above subset of practices a stratified random sample of 122 veterinary clinics was chosen using a 2-step process. At the interprovincial level, the number of practices chosen from each province was proportional to the total number of beef cows reported by Statistics Canada (7). At the provincial level, census data were used to generate a map of beef cattle densities, on which were superimposed the location of the veterinary clinics. Clinics in high density cattle regions were then invited to participate in the survey. The number of practices contacted was limited by research funds.

Recruitment of cow-calf producers and data collection

In June 2010, veterinary practices were mailed packages containing an invitation letter, instructions for identifying study participants (beef producers), and "producer packages." Practices were instructed to randomly select 16 clients who had ≥ 20 cows calve between January and June 2010. The veterinary practices provided each eligible producer with a producer package containing a letter outlining the study's objectives, the survey questionnaire, and a self-addressed, postage paid, return envelope. The questionnaires were anonymous, containing no personal information that could identify individual clients; however, a code linked the participants to the practices.

The survey questionnaire was divided into 4 parts. Part 1 examined the frequency and timing of neonatal diarrhea (scours) in the herd. Part 2 was devoted to the timing and occurrence of non-scours related morbidity and mortality. Part 3 examined the use of vaccines and colostrum supplements. Part 4 asked about the use of veterinary services and of ancillary or supportive treatments for sick calves. Treatment questions related specifically to the number of calves treated for sickness from January 1 to May 31, 2010, where treatment was defined as a calf receiving either oral/parenteral antibiotics or oral/IV fluid therapy.

Data management and analysis

Responses received before September 30, 2010 were included in the analysis. Some producers failed to provide data for every question, hence the number of herds reporting (denominator) varied by question. Analyses of disease data were limited to herds with > 90% of the calves born before June 1, thereby ensuring that most calves were > 1 mo of age at the time of the survey. Only herds in which > 90% of the calves were born before April 1 were included in the calculation of disease occurrence for calves from 1 to 3 mo of age.

The data were entered on a commercial spreadsheet program (Microsoft Excel) and the same software was used to generate descriptive statistics. Generalized estimating equations (GENMOD Procedure, SAS for Windows version 9.2, SAS Institute, Cary, North Carolina, USA), assuming a normal distribution and accounting for repeated measures within veterinary practice, were used to examine the association between both the start of calving date (date when 10% of calves were born) and the length of the intensive calving period (time when 10% of the calves were born to when 90% of the calves were born) and herd size.

Generalized estimating equations with a logit link function and binomial distribution were used to examine a series of simple unconditional associations between management factors and measures of disease frequency while accounting for clustering by veterinary practice. McNemar's chi-square was used to look for differences between the likelihood of vaccinating cows and heifers with clostridial and scour vaccines.

Measures of disease frequency considered as outcomes included: whether the producer had treated > 10% of calves for scours in 2010; whether they had treated > 10% of their calves for scours at any time in the last 3 calving seasons (2008, 2009, and 2010); the proportion of calves treated for scours in 2010; the proportion of calves treated for pneumonia in 2010; and the proportion of the total calf crop that died from birth to 1 mo of age. Management factors considered as potential risk factors included: herd size (total number of cows calving); time of calving (month when 10% of the calves were born); use of scours and/or clostridial vaccines; whether the vaccines were administered in the fall or spring of the year; and veterinary services usage.

Variables in the unconditional analyses with a P-value of < 0.20 were considered for inclusion in the multivariable regression model. Backwards elimination was used to establish a model with factors that were either statistically significant ($P < 0.05$) or important confounders. First-order interaction terms were evaluated where > 1 main effects were retained in the final model. Only the results of the final model are reported for each outcome.

Table 1. Summary of herd calving and death loss outcomes and reasons for calf treatment and type of treatment by number of herds reporting

	Number of herds	Percentiles for herds reporting				
		5th	25th	Median	75th	95th
Herd and calf loss records						
Number of cows and heifers calving	304	32	85	136	220	529
Percent of cows and heifers with twins	302	0.0%	1.2%	2.3%	3.9%	6.6%
Percent of calves born dead or within the first hour of birth	303	0.0%	0.8%	1.6%	2.9%	5.7%
Percent of calves born alive but died within the first 3 d of birth	303	0.0%	0.0%	0.2%	1.1%	2.7%
Percent of calves that died between 4 d and 1 mo after birth[a]	272	0.0%	0.0%	0.5%	1.2%	3.0%
Total percent of calves that died from birth to 1 mo[a]	272	0.0%	1.9%	3.3%	4.7%	8.4%
Percent of calves that died between 1 mo and 3 mo after birth[b]	56	0.0%	0.0%	0.4%	1.2%	2.7%
Herd treatment records						
Percent of calves treated for diarrhea[c]	300	0.0%	0.0%	2.4%	6.0%	17.6%
Percent of calves treated for pneumonia[c]	301	0.0%	0.0%	0.8%	2.9%	9.8%
Percent of calves treated for navel ill[c]	301	0.0%	0.0%	0.0%	1.4%	6.6%
Percent of calves treated for injury[c]	301	0.0%	0.0%	0.0%	0.3%	1.8%
Percent of calves treated with no specific diagnosis[c]	302	0.0%	0.0%	0.4%	1.4%	5.8%
Type of treatments reported						
Percent of calves treated with oral antibiotics[c]	298	0.0%	0.0%	2.0%	6.9%	18.3%
Percent of calves treated with injectable antibiotics[c]	298	0.0%	1.4%	4.0%	8.7%	27.6%
Percent of calves treated with oral electrolytes[c]	298	0.0%	0.0%	1.0%	2.5%	8.6%

[a] Only herds in which at least 90% of the calves were born before June 1st were included in this calculation.
[b] Only herds in which at least 90% of the calves were born before April 1st were included in this calculation.
[c] This is summarized as a percentage of calves from each reporting herd alive at 1 h after birth and at risk of treatment.

Results

Survey participation rates, herd size, and herd loss outcomes

Five of the 122 veterinary clinics selected for the study were excluded because they had no cow-calf clients. Of the remaining 117 clinics, 62 (53%) had ≥ 1 client participate in the study, for a total of 310 responses. From British Columbia, 27 surveys were returned from 5 of 8 clinics; Alberta, 161 surveys were returned from 29 of 51 clinics; Saskatchewan, 95 surveys were returned from 22 of 42 clinics; and Manitoba, 27 surveys were returned from 6 of 16 clinics.

The percentages (numbers) of farms that began their intensive calving seasons in each month were as follows: December 2009, 0.3% (n = 1); January, 13.2% (n = 41); February, 23.9% (n = 74); March, 38.7% (n = 120); April, 21.0% (n = 65); and May, 2.9% (n = 9). The average date when 10% of the calves were born was March 14 and the average date when 90% of the calves were born was April 29. The average number of calving days from the 10th and 90th percentile of the calf crop was 46 [± 21 standard deviation (SD)]; this period extended to > 94 d in 5% of herds. The average number of cows and heifers calving per herd (n = 304 herds) was 200 (± 232 SD), 14.7% of which were heifers with their 1st calf; median herd size was 136 with 25% of herds having ≥ 220 bred females (Table 1). Smaller herds began calving sooner than the larger herds (P = 0.001), but herd size was unrelated to the length of the intensive calving period (P = 0.52).

Calf death loss was highest between birth and 1 mo with an average across all herds of 3.7% (± 1.6% SD) (Table 1). Calf loss between 1 to 3 mo was lower at 0.8% (± 1.0% SD). The mean percentage of calves that died during the 1st month of life was as follows: stillborn to 1 h, 2.1% (± 2.0% SD); 1 h to 3 d, 0.7% (± 1.1% SD); and 4 d to 1 mo, 0.9% (± 1.6% SD).

Frequency and timing of calf diseases and treatment regimens

Half (50.3%) of the respondents identified scours or coccidiosis as the most important diseases affecting calf health, followed by pneumonia and other respiratory conditions (33.9%); navel ill or infectious arthritis (7.4%); extreme weather (6.8%); ear infection or droopy ears (4.5%); bovine viral diarrhea virus (BVDV) (3.5%); abomasal ulcers (3.2%); and blackleg (2.3%). The mean percentage of calves treated in 2010 for diarrhea was 5.5% (± 11.1% SD), pneumonia 2.7% (± 7.7% SD), navel ill 1.3% (± 2.4% SD), injury 0.4% (± 1.0% SD), and no specific diagnosis 1.3% (± 2.6% SD). Of the 42 producers (14%) who reported treating ≥ 10% of calves for neonatal diarrhea in 2010, 40 provided data on the age of onset: < 3 d, 0.0%; 3 to 7 d, 7.5%; 1 to 2 wk, 35.0%; 2 to 4 wk, 25.0%; 4 to 6 wk, 27.5%; and > 6 wk, 5.0%. Lastly, 28.2% (79/280) of producers treated > 10% of calves for neonatal diarrhea in at least 1 of the last 3 calving seasons.

The average percent of calves treated for all diseases with oral antibiotics was 5.5% (± 11.0% SD); parenteral antibiotics, 8.9% (± 17.2% SD); and oral electrolytes, 2.2% (± 5.5% SD) (Table 1). A variety of other calf treatments was used by 17.6% (54/306) of herd owners, including (from most to least common): yogurt, Amprol, salt and soda water, Pepto-bismol, kaopectate, Immodium, homemade electrolytes, garlic, charcoal powder, diatomaceous earth, Metacam, Banamine, eggs, baking soda, hydrogen peroxide, and subcutaneous fluids.

Use of colostral supplements, treatments, and vaccines in calves prior to pasture turn-out

Supplemental colostrum was provided to ≥ 1 calf in 76.8% (238/310) of herds; 49.8% (154/309) of herds gave supplemental colostrum to calves born to heifers and 69.3% (214/309)

supplemented calves born to cows. The most common source of colostrum was commercial powders (53.2%, 165/310), followed by colostrum derived from the producer's own herd (44.5%, 138/310), dairy-derived colostrum (7.1%, 22/310), and other (1.9%, 6/310).

The most commonly administered injections given within the first few days of birth were supplemental selenium (42.8%, 131/306) and vitamins A and D (38.1%, 117/307). The routine use of long-acting antibiotics at birth (14.4%, 44/306) and navel dips/sprays (9.1%, 28/307) was less common. Some respondents (8.8%, 27/306) reported the use of other treatments including: oral calf scours vaccines, vitamin E capsules, diatomaceous earth, clostridial vaccines, vitamin B, and *Mannheimia haemolytica* or *Histophilus somnus* vaccines.

Most (85.3%, 261/306) owners vaccinated their calves before the herd was moved to summer pasture. The most commonly used vaccines were for clostridial diseases (84.6%, 259/306); BVDV and infectious bovine rhinotracheitis (IBR) (55.6%, 170/306); and "other" respiratory pathogens (32.0%, 98/306). A small percentage of producers (12.1%, 37/306) treated their calves with Ivomec, long-acting antibiotics, anthrax vaccines, pinkeye vaccines, parenteral vitamin A and D, and other combination vaccines of which many included vaccines for *Histophilus somnus.*

Vaccines administered to pregnant heifers and cows

Similar proportions of producers vaccinated their cows (41.9%, 130/310) and heifers (41.6%, 129/310) at least once for scours ($P = 0.85$). Producers with > 220 pregnant dams (highest quartile for herd size, designated as "*large herds*") were more likely to vaccinate for scours [odds ratio (OR): 3.5; 95% confidence interval (CI): 1.8 to 6.7; $P = 0.0001$] and clostridial diseases (OR: 2.4; 95% CI: 1.3 to 4.5, $P = 0.007$) than were those with < 85 dams (lowest quartile for herd size, designated as "*small herds*"). There was no association between scours vaccination and the proportion of calves treated for scours either after accounting for clostridial vaccine and herd size ($P = 0.19$), or in a model accounting only for herd size ($P = 0.27$).

Overall, producers were more likely to vaccinate their cows or heifers for clostridial diseases (57.1%, 177/310) than for scours (*E. coli,* rotavirus, or coronavirus) (46.5%, 144/310) ($P = 0.01$). There was no difference in the proportion of producers who vaccinated their heifers (51.3%, 159/310) versus their cows (47.7%, 148/310) for clostridial diseases prior to calving ($P = 0.11$). More producers administered a clostridial vaccine to their cows (37.1%, 115/310) and heifers (42.9%, 133/310) in the fall than in the spring (cows 16.8%, 52/309; bred heifers 18.4%, 57/309) ($P < 0.001$). Herds that were vaccinated in the fall (OR: 1.85; 95% CI: 1.20 to 2.87; $P = 0.01$) and the nonvaccinated herds (OR: 1.52; 95% CI: 1.04 to 2.21; $P = 0.03$) had more calves treated for scours than herds that were vaccinated in the spring before calving, after controlling for herd size and the use of scour vaccine.

Veterinary services usage and the association with herd size and disease

Herd owners who sought veterinary advice were more likely to report a higher frequency of both scours (OR: 1.86; 95% CI: 1.20 to 2.91; $P = 0.01$) and pneumonia (OR: 2.52; 95% CI: 1.55 to 4.11; $P = 0.01$) than those who did not seek advice. A majority of producers (62.7%, 192/306) consulted with a veterinarian for treating sick calves and 23.5% ($n = 72$) had a veterinarian examine or treat ≥ 1 sick calf in the spring of 2010. At least 1 calf from 7.2% ($n = 22$) of herds was treated with IV fluids at a veterinary clinic and ≥ 1 calf from 2.6% ($n = 8$) of herds were treated with IV fluids on the farm. Furthermore, 9.8% (30/305) of producers had a veterinarian perform a post-mortem examination on ≥ 1 calf in 2010 and 5.2% ($n = 16$) of respondents had veterinarians submit tissues or biological samples to a diagnostic laboratory.

There were no associations between herd size and having a veterinarian examine or treat a sick calf ($P = 0.37$), administer IV fluids to a calf in the veterinary clinic ($P = 0.24$), or submit biological samples for further testing ($P = 0.69$). However, producers with large herds were 2.2 times more likely than the small herd producers to seek veterinary advice for treating sick calves (95% CI: 1.1 to 4.6; $P = 0.03$) and 7.3 times more likely to have had a veterinarian perform a postmortem examination on dead calves (95% CI: 1.4 to 36.6; $P = 0.02$).

Nearly 50% (151/305) of producers had a veterinarian pregnancy test their cows and heifers in the fall of 2009 and 60.3% (184/305) had a breeding soundness examination performed on ≥ 1 bull in the spring of 2010. Herd size was an important determinant for use of these veterinary services. Large producers were 5.0 times more likely (95% CI: 2.7 to 9.4; $P = 0.0001$) than small producers to have had a veterinarian pregnancy test their bred females in the fall of 2009 and were 2.7 times more likely (95% CI: 1.5 to 4.9; $P = 0.001$) to have had a veterinarian evaluate ≥ 1 herd bull for breeding soundness.

Associations between timing of the calving season, herd size, and disease frequency

Both the timing of the calving season and the size of the herd were associated with the percentage of calves treated for scours or pneumonia. For every 1 mo delay in the start of the calving season, the odds of having had to treat > 10% of calves at least once in the past 3 y decreased by 1.40 times (95% CI: 1.07 to 1.83; $P = 0.015$). This relationship also applied to treating calves for pneumonia; the odds of reporting that a calf was treated for pneumonia decreased by 1.79 times (95% CI: 1.50 to 2.14) for every month calving season was delayed. As for herd size, every additional 50 cows in herd size reduced the odds of having to treat > 10% of calves for scours by 1.28 times (95% CI: 1.06 to 1.54; $P = 0.01$).

Discussion

Increasing herd size was associated with a later start to the calving season, increased usage of veterinary services, greater use of clostridial and scour vaccines, and a reduction in the proportion of calves treated for scours. These findings are of particular interest because, as previously discussed, socioeconomic forces are remodeling the beef cattle industry, resulting in fewer but larger operations; Statistics Canada's data (8,9) show that the average number of breeding females per cow-calf operation in western Canada increased from 56 to 73 (30%) between 2000 and 2011.

If the cow-calf sector continues its path of consolidation, then the findings associated with the large herds described in the current study could represent the average herd of the future.

The mean and median herd sizes reported for this study were 200 and 136 pregnant females, respectively. These numbers are well above the average for cow-calf operations in western Canada, which raises an important point with regards to interpreting the survey results. Specifically, the survey data were generated using veterinarians as intermediaries to identify potential survey participants and the results were intended to represent those producers who were intensive users of veterinary services rather than a cross-section of all cow-calf operators in western Canada. Therefore, the data reflect a "best-case scenario" with respect to veterinary services usage, adoption of vaccination protocols, and herd health parameters.

Regarding the use of veterinary services, ~50% of respondents pregnancy-tested in the fall and ~60% had 1 or more bulls evaluated for breeding soundness. These numbers are similar to those reported in the 2007–2008 NAHMS study wherein 42.1% of beef producers in the western United States utilized rectal palpation/ultrasound for pregnancy diagnosis and 31.3% semen-tested their bulls (10); these veterinary service utilization rates also increased with herd size. Similarly, in our study, large herds were 5 times more likely than small herds to pregnancy test and nearly 3 times more likely to have their bulls semen-tested. The NAHMS study also noted that labor and time, along with cost, were the main deterrents for pregnancy testing and performing breeding soundness examinations. We also speculate that the larger herd producers, who have more capital resources at stake, perceive a different value proposition in having veterinarians perform these services than do the smaller herd operators.

Herd size influenced management practices and the level of disease, or perhaps more accurately the reported occurrence of disease. Compared with small herd producers, large herd producers were 3.5 times more likely to use a scour vaccine, 2.4 times more likely to vaccinate the dams for clostridial diseases, and twice as likely to have consulted with a veterinarian regarding the treatment of sick calves. While larger herd producers were more likely to seek veterinary advice, they were no more likely to have had a veterinarian examine or treat their sick calves or to have taken their calves to a veterinary clinic for IV fluid therapy. Paradoxically, large herds were 7 times more likely to have had a veterinarian necropsy dead calves, but were no more likely to have had a veterinarian submit samples to a diagnostic laboratory. These findings are indicative of how producers are managing their interactions with veterinarians. The larger herd producers appear to be more attuned to the concepts of herd health, specifically, the use of vaccines, asking for veterinary advice, and utilizing necropsies to make informed management decisions.

In this study, 2.1% of all calves born were stillbirths, similar to the 1987 study conducted by McDermott et al (11) in Ontario and a series of NAHMS studies conducted in 1992 (12), 1997 (13), and 2007–2008 (14). While the risk factors associated with stillbirths have been known for decades (15–17), it is uncertain whether the stillbirth rate has improved over

the last 2 to 3 decades. It is also important to appreciate that as herds get larger, individual animal surveillance is likely to become less intensive, making calf losses due to all causes more difficult to observe, categorize, and quantify. As a result, the potential for reporting biases could create a false impression that health and production parameters are improving.

The study avoided asking producers to diagnose causes of death in their calves because we are aware that even veterinarians frequently rely on histopathology and other ancillary tests to make a definitive diagnosis (18). We do believe, however, that most producers can differentiate the clinical signs of the most common calf-hood diseases. Half of all producers reported treating at least 2.4% of their calf crop for scours, while 5% treated > 17.6% of their calves for scours. No other identifiable disease had a similar level of morbidity, and the spring of 2010 was not unique; ~28% of producers had to treat > 10% of their calves for scours in at least 1 of the last 3 years. Unfortunately, because of a lack of historical Canadian data, coupled with different study designs, we could not definitely determine whether neonatal and calf-hood disease rates are changing.

Although calf scours remains the primary reason for treating calves, only ~42% of producers vaccinated their heifers and cows for scours. This was, however, an improvement from the 9% reported in a 1983 Ontario study (19) and the 32% to 35% reported in a 2002 study of western Canadian beef operations (20). The 2007 NAHMS study reported that only 5.3% and 5.5% of American beef producers vaccinated their cows for rotavirus/coronavirus and *E. coli*, respectively (14), and these rates were essentially unchanged from 1993 (21). Although the larger operators were more likely to use scour vaccines, there was no association between scour vaccine usage and a reduction in the proportion of calves treated for scours. This latter finding was not unique to this study; a Quebec study found preweaning mortality associated with scours was higher in herds that vaccinated for scours than those that did not (22). A study conducted in 1988 by Schumann et al (23) also found that *E. coli* and viral diarrhea vaccines did not significantly decrease the odds of high mortality due to diarrhea in calves < 30 d of age.

Administering clostridial vaccines to pregnant dams in the spring was associated with a decrease in the reported frequency of scours compared with not vaccinating or to vaccinating in the fall. Research has shown that vaccinating pregnant females 124 d prior to calving provided protective antibody titers in the calf until ~50 d of age (24). Perhaps maternal antibodies protect against *Clostridium perfringens*, a pathogen identified as causing enteritis in calves (25). Alternatively, the clostridial agents could be acting as secondary opportunistic invaders after diarrhea-associated pathogens have devitalized the enteric mucosa, leading to more severe cases of diarrhea that necessitate treatment.

In addition to vaccine usage, other management practices were associated with a reduction in the treatment for calf diarrhea and pneumonia. Larger and later calving herds treated fewer sick calves. One potential explanation is that these herds were not confined for calving; rather they were managed on larger tracts of land with less intensive exposure to infectious agents. The reduction in treatment rate might also be attributed to less

intensive surveillance and the added difficulty in catching and treating marginally depressed animals on open pastures. A later calving season might also minimize exposure to the inclement weather common to early spring in western Canada.

In summary, this study confirmed that larger herd producers are more intensive users of herd level veterinary services than their smaller counterparts, which has implications not only for veterinary practices but also for training future beef cattle practitioners. Secondly, there was no association between vaccinating for scours and the number of calves treated for this condition. Thirdly, the use of clostridial vaccines in pregnant cows before calving was associated with a decrease in the frequency of calf scour treatment. Further research is needed to provide cost-effective advice on the use of vaccine to prevent calf scours. CVJ

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